Current Development Activities with Airborne Turbulence Detection Systems (ATDS)

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Presentation Outline

- ✈Background
- ✈Turbulence Accident Assessment
- ✈Technology
- ✈Conclusions

Background

'97 WHITE HOUSE COMMISION

1.1 Government and industry should establish a national goal to reduce the aviation fatal accident rate by a factor of five within ten years and conduct safety research to support that goal.

1.2 The FAA should develop standards for continuous safety improvement, and should target its regulatory resources based on performance against those standards.

Background

Additional Direction

From

National Civil Aviation Review Commission (NCARC)

- **FAA and the aviation industry must develop a strategic plan to improve safety, with specific priorities based on objective, quantitative analysis of safety information and data.**
- **Government should expand on their programs to improve aviation safety in other parts of the world.**

Background

Commercial Aviation Safety Team (CAST)

Industry

AIA	Boeing
Airbus	P&W*
ALPA	RAA
APA	FSF
ATA	IATA

Government

DOD	NASA
FAA	ICAO
• Aircraft Certification	JAA
• Flight Standards	
• System Safety	
• Air Traffic Operations	
• Research	

Background

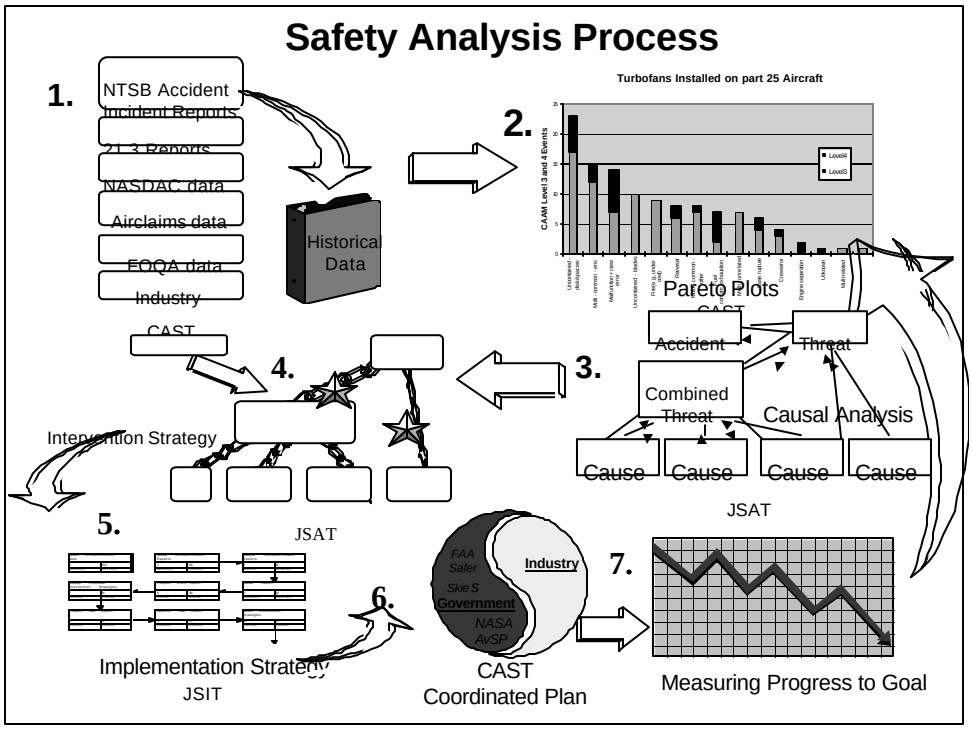
Commercial Aviation Safety Team (CAST)

Mission: Utilize Resources and leadership within government and industry to develop and focus an integrated, data driven strategy to improve commercial aviation Safety.

Background

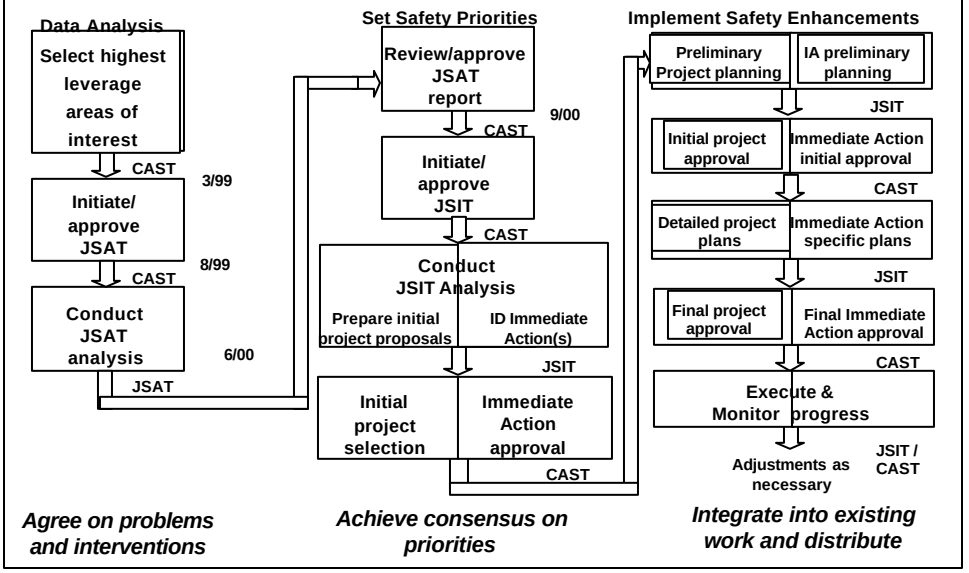
Safety Analysis Process

- CAST
  - Historical Data Consolidation
  - Threat Definitions
- Joint Safety Analysis Team (JSAT)
  - Causal Analysis
  - Intervention Strategy 8/30/00
- Joint Safety Implementation Team (JSIT)
  - Implementation Strategy



Background

JSAT Progress Status in the CAST Process



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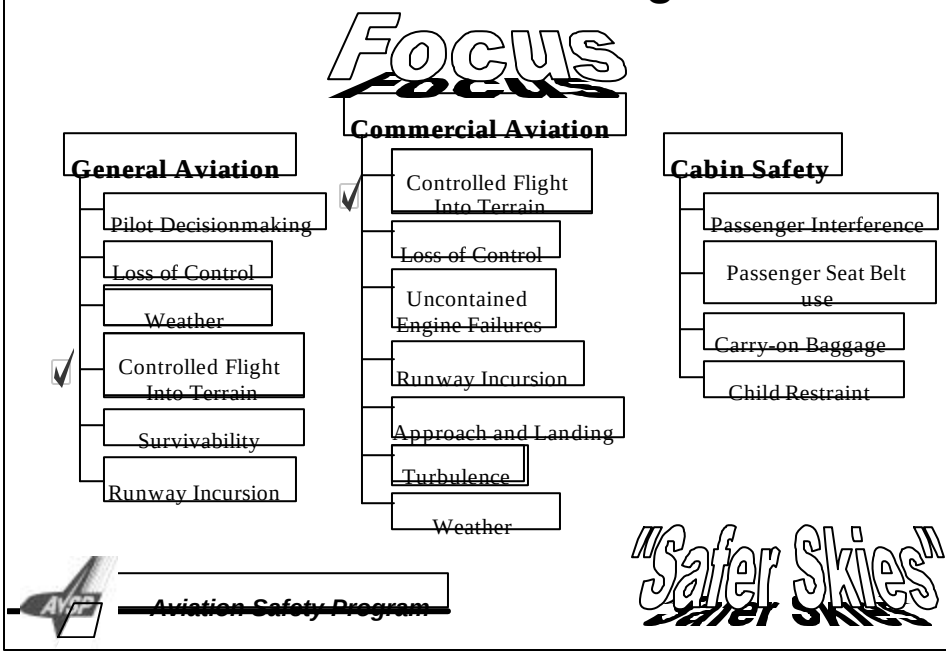


Background

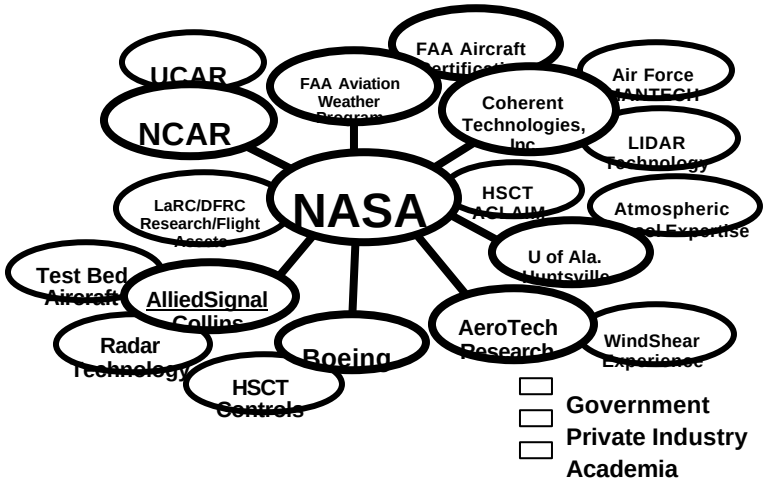
NASA

Aviation Safety Program

- Build a Turbulence Team from Industry, Academia, and Government to address requirements, approaches, and solutions
- Utilize the Commercial Aircraft Safety Team (CAST) to determine requirements for Air Carriers
- Address Air Carrier Issues with Technology Approaches Combined with Rule-Making, and Improved Procedures
- Address GA Issues with improved Weather Products Disseminated through AWIN

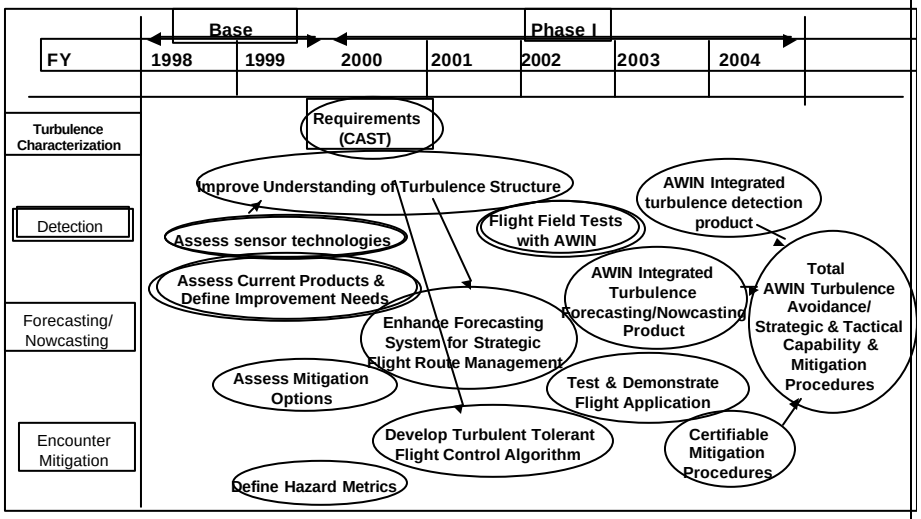
Background

Turbulence Team Relationships



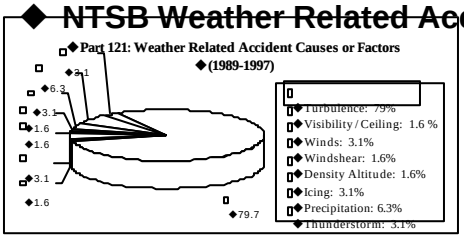
Background

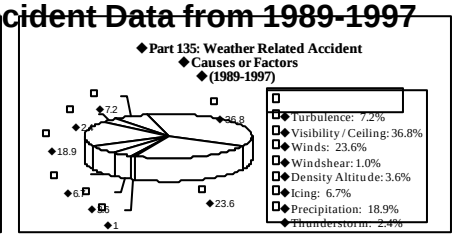
NASA Schedule Under AvSP

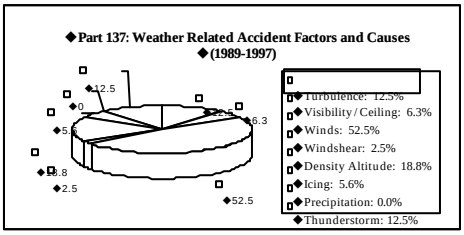


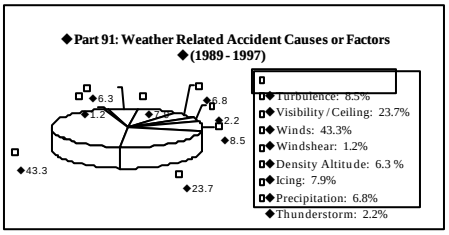
Turbulence Accident Assessment

- **NTSB Weather Related Accident Data from 1989-1997**









Turbulence Accident Assessment

44 Accident Case Study

Location Distribution

WARM OCEAN	7
NORTHWEST	5
SOUTHWEST	3
NORTH CENTRAL	6
SOUTH CENTRAL	7
NORTHEAST	6
SOUTHEAST	10

Diurnal Distribution

01-04Z	8
05-08Z	4
09-12Z	2
13-16Z	5
17-20Z	10
21-00Z	15

Altitude Distribution

1-10000ft	5
10k-20k ft	5
20k1-30k ft	10
30k-38k ft	16
38k-48k ft	4
>48k ft	0

Annual Distribution

JANUARY	3	JULY	8
FEBRUARY	1	AUGUST	4
MARCH	6	SEPTEMBER	2
APRIL	2	OCTOBER	3
MAY	3	NOVEMBER	3
JUNE	7	DECEMBER	2

Turbulence Accident Assessment

Turbulence Initiators

- Convective Storms (within and as far as 40 miles away from visible clouds in clear air)
- Jet Stream (at confluence of multiple streams and near boundaries)
- Mountain Wave (upward propagating from disturbances near the surface)

Turbulence Accident Conclusions

Conclusions from Accident Assessment

- Turbulence Costs
  - Leading Cause of In-Flight Injuries
  - Cost estimated at >$100M/yr. for airlines
- Advanced warning may have an impact on accident statistics
  - 84% of encounters had no crew warning
  - Seat-Belt Sign status had little effect on injuries - BUT a believable warning may impact injuries
  - In 64% of the encounters, the seat belt sign was ON
  - Keeping Passengers belted has little or no effect on Attendant Injuries (not too surprising) In 73% of the encounters Flight Attendants were injured

Turbulence Accident Conclusions

NASA

Aviation Safety Program

Requirements in Response to Accident Data Conclusions

- **Reliable Tactical Warning**
  - Provide timely warning to deviate or to institute cabin safety measures
  - Provide real-time alerts to AWIN network
- **Reliable Forecasting/Nowcasting**
  - Collaborate with FAA to provide improved Forecasting/Nowcasting at useful resolutions for pre-takeoff strategic turbulence avoidance planning
- **Encounter Mitigation**
  - Develop technology to reduce severity of turbulence encounter experience

Turbulence Accident Conclusions

NASA

Aviation Safety Program

Technical Approach - Technology Transfer

- Upgrade Existing Installed Base
  - Weather radar turbulence algorithm
  - Turbulence tolerant flight control system
- Industry Buy-In
  - CAST requirements definition
  - Industry-based JSAT & JSIT groups
- Multi-Functional Technology
  - Lidar
  - ADS-B

Technology

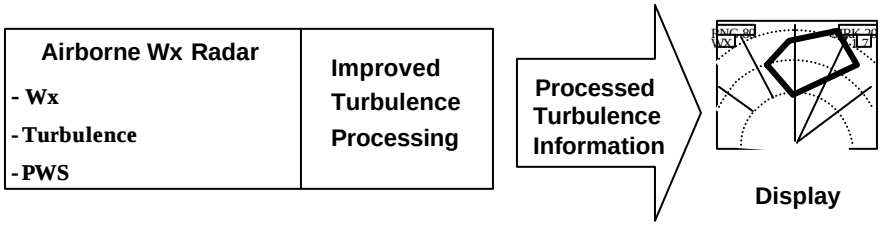
Current Radar Turbulence Detection

- Most solid-state digital radars have turbulence detection capability with limitations:
  - Low sensitivity; requires significant precipitation for processing
  - Subject to false indication in presence of ground clutter
  - Manual operation only
  - No crew alerting capability

Technology

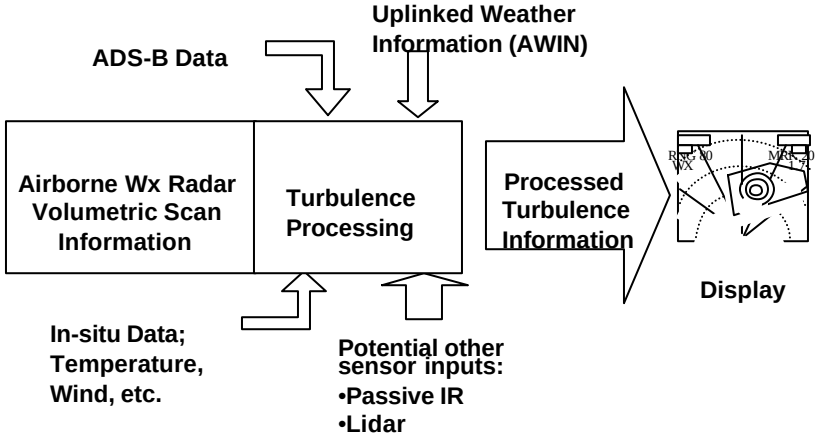
Near Term Turbulence Mode Improvements

- ✈Better Threshold Tables Utilizing TAS, GS, BARO ALT Inputs
- ✈Incorporate Generic Airplane Model for Hazard Threshold
- ✈Use PWS Waveforms for Better Short Range Detection (<10nm)
- ✈Automatic Operation During Climb-Cruise-Descent
- ✈Antenna Scan Transparent to Crew
- ✈Advisory/Caution Alerts for Better Crew Awareness



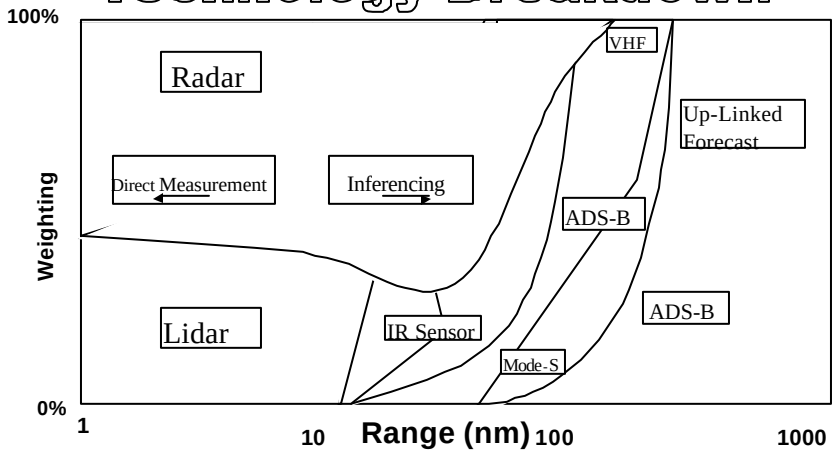
Technology

Long Term Turbulence Mode Improvements



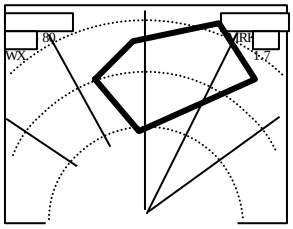
Technology

Technology Breakdown



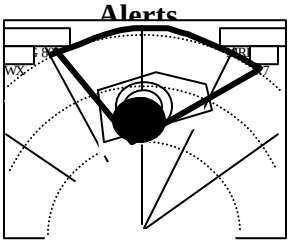
Technology

Example of Proposed Displays



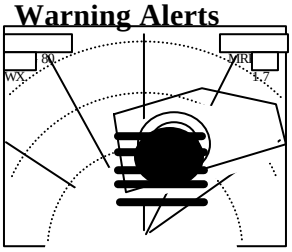
Long Range: 100-640 nmiles: Strategic Information

Advisory/Caution Alerts



Medium Range: 20-120 nmiles: Avoidance Information

Warning Alerts



Short Range: 3-20 nmiles: Penetration Information

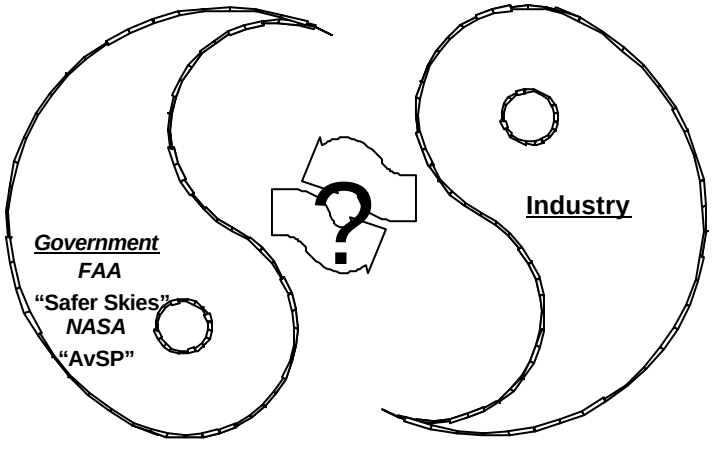
Conclusions

Vendors Schedule

- Near Term
  - Both Honeywell and Collins are developing enhanced Turbulence upgrade detection to air transport radar for certification in **2001**
- Long Term
  - Both Honeywell and Collins are looking at integration of several technologies for turbulence detection in **2003 and Beyond**

Conclusions

Coordinated Plan



Conclusions

Industry Working Group

Industry Working Group Needed To Establish Standards

- Performance Standards
  - Turbulence Characteristics / Models
  - Acceptable POD - FAR Standards
  - Operational Expectations - i.e. Minimum Radar Reflectivity, Turbulence Severity, etc
- Cockpit-Crew Interfaces
  - Aural Alerts
  - Visual Alerts
  - Icon / Radar Displays
- Flight Crew Actions

What's Now??? BREAK !!!!